CLAIMS

What is claimed is:

1.   A method of indexing shapes including the steps of:

inputting a digital page into a computer system, the digital page including information including a shape and extraneous information;

removing the extraneous information; and

orienting the shape in a predetermined orientation.

2.   The method of claim 1 wherein the extraneous information includes a border and a title block.

3.   The method of claim 1 wherein the step of removing the extraneous information includes the step of identifying a border and a title block and removing the border and the title block.

4.   The method of claim 3 wherein the step of identifying a border and a title block includes the steps of locating pixels adjacent a perimeter of the digital page that correspond to extraneous information, and performing a line fit analysis using the pixel locations to determine whether the pixels lie on a line.

5.   The method of claim 1 wherein the step of removing the extraneous information includes the step of reducing the shape for faster processing.

6.   The method of claim 1 wherein the step of removing the extraneous information includes the steps of identifying all objects on the digital page, assuming the shape is the largest object on the page, and removing all objects except the largest object.

7.   The method of claim 6 wherein the step of identifying all objects on the digital page includes the step of locating adjacent pixels of information on the digital page, and defining objects as collections of contiguous pixels of information.

8.   The method of claim 1 wherein the step of removing the extraneous information includes the step of backfilling the digital page to locate an interior space of the shape.

9.   The method of claim 8 wherein the step of backfilling includes the steps of backfilling a portion of the digital page outside the shape with a first color, and filling all other portions of the digital page with a second color.

10. The method of claim 1 wherein the step of removing the extraneous information includes the step of removing information having a width of a single pixel.

11. The method of claim 1 wherein the step of orienting the shape includes the step of identifying the center of mass of the shape.

12. The method of claim 1 wherein the step of orienting the shape includes the step of rotating the shape.

13. The method of claim 11 further including the step of rotating the shape so that the center of mass is in a predetermined location relative to a pair of axes.

14. The method of claim 1 wherein the information includes layers of information.

15. The method of claim 14 wherein the step of removing the extraneous information includes the step of asking a user to identify a layer that likely contains the shape and a layer that does not likely contain the shape.

16. The method of claim 15 wherein the step of removing the extraneous information includes the step of determining whether the layer identified as likely containing the shape includes an arc.

17. The method of claim 14 wherein the step of removing the extraneous information includes the step of ignoring layers of information that do not include an arc.

18. The method of claim 14 wherein the step of removing the extraneous information includes the step of defining a sub-layer of information as including information from a layer having a common characteristic.

19. The method of claim 18 wherein the common characteristic is one of color and width.

20. The method of claim 18 wherein the step of removing the extraneous information includes the step of removing any lines and arcs within the sub-layer having an open end point.

21. The method of claim 18 wherein the step of removing the extraneous information includes the step of defining a sub-sub-layer of information as including information from the sub-layer forming a closed shape.

22.   The method of claim 21 wherein the step of defining a sub-sub-layer includes the step of removing any lines and arcs within the sub-sub-layer having an open end point.

23.   The method of claim 14 wherein the step of removing extraneous information includes the step of identifying, for each of a plurality of layers, an object having an area that is larger than the area of any other object on the particular layer.

24.   The method of claim 23 wherein the step of removing extraneous information includes the step of comparing the objects identified as having the largest area on their particular layer to identify the largest object on the digital page.

25.   The method of claim 1 wherein the step of orienting the shape in a predetermined orientation includes the step of determining an angle relative to an x axis that is common to a largest number of lines included in the shape.

26.   The method of claim 25 wherein the step of orienting the shape in a predetermined orientation includes the step of rotating the shape by an angle that is equal to the common angle.

27.   The method of claim 26 wherein the step of orienting the shape of includes the step of determining a physical center of the shape and a center of mass of the shape.

28.   The method of claim 27 wherein the step of orienting the shape includes the steps of defining a pair of perpendicular axes that pass through the physical center and rotating the shape relative to the axes so that the center of mass is located in a predetermined quadrant defined by the axes.

29.   A method of identifying shapes stored in a database that are identical or similar to a search shape, including the steps of:

inputting a drawing including information including the search shape and other information;

eliminating the other information;

calculating the center of mass of the search shape;

positioning the search shape so that the center of mass is in a predetermined orientation; and

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comparing the search shape to the shapes stored in the database.

30.   The method of claim 29 further including the step of outputting the stored shapes that are identical or similar to the search shape.

31.   The method of claim 29 wherein the step of eliminating the other information includes the step of identifying a border and a title block and removing the border and the title block.

32.   The method of claim 31 wherein the step of identifying a border and a title block includes the steps of locating pixels of information adjacent a perimeter of the drawing and determining whether the located pixels lie on a line.

33.   The method of claim 29 wherein the step of eliminating the other information includes the step of reducing the search shape for faster processing.

34.   The method of claim 29 wherein the step of eliminating the other information includes the steps of identifying all objects on the drawing, assuming the search shape is the largest object, and removing all objects except the largest object.

35.   The method of claim 34 wherein the step of identifying all objects on the drawing includes the step of locating adjacent pixels of information on the drawing, and defining objects as collections of contiguous pixels of information.

36.   The method of claim 29 wherein the step of eliminating the other information includes the step of backfilling the drawing to define an interior space of the search shape.

37.   The method of claim 36 wherein the step of backfilling includes the steps of backfilling a portion of the drawing outside the search shape with a first color, and filling other portions of the drawing with a second color.

38.   The method of claim 29 wherein the step of eliminating the other information includes the step of removing information having a width of less than a predetermined number of pixels.

39.   The method of claim 29 wherein the step of positioning the search shape includes the step of rotating the search shape so that the center of mass is in a predetermined orientation relative to a pair of axes.

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40. The method of claim 29 wherein the information includes layers of information.

41. The method of claim 29 wherein the step of eliminating the other information includes the step of asking a user to identify a layer that likely contains the search shape and a layer that does not likely contain the search shape.

42. The method of claim 41 wherein the step of eliminating the other information includes the step of determining whether the layer identified as likely containing the search shape includes an arc.

43. The method of claim 40 wherein the step of eliminating the other information includes the step of ignoring layers of information that do not include an arc.

44. The method of claim 40 wherein the step of eliminating the other information includes the step of defining sub-layers of information from a layer of information, the information of each sub-layer having a common characteristic.

45. The method of claim 44 wherein the common characteristic is one of color and width.

46. The method of claim 44 wherein the step of eliminating the other information includes the step of removing, within each sub-layer, any lines and arcs having an open end point.

47. The method of claim 44 wherein the step of eliminating the other information includes the step of defining, for each sub-layer including a closed shape, a sub-sub-layer of information including the closed shape.

48. The method of claim 47 wherein the step of defining a sub-sub-layer includes the step of removing any lines and arcs within the sub-sub-layer having an open end point.

49. The method of claim 40 wherein the step of eliminating the other information includes the step of identifying, for each layer, an object having an area that is larger than the area of any other object on the particular layer.

50. The method of claim 49 wherein the step of eliminating the other information includes the step of comparing the objects identified as having the largest area on their particular layer to identify the largest object on the drawing.

51.   The method of claim 29 wherein the step of positioning the search shape includes the step of determining an angle relative to an x axis that is common to a largest number of lines included in the search shape.

52.   The method of claim 51 wherein the step of positioning the search shape includes the step of rotating the search shape by an angle that is equal to the common angle.

53.   The method of claim 52 wherein the step of positioning the search shape of includes the step of determining a physical center of the search shape.

54.   The method of claim 53 wherein the step of positioning the search shape includes the steps of defining a pair of perpendicular axes that pass through the physical center and rotating the shape relative to the axes so that the center of mass is located in a predetermined quadrant defined by the axes.

55.   A shape retrieval program including:

an indexing routine for generating a database of indexed shapes by processing shapes included on inputted drawings also having extraneous information, the indexing routine including a procedure for removing the extraneous information on each inputted drawing, a procedure for orienting the indexed shape in a predetermined orientation, and a procedure for storing the indexed shape in the database; and

a querying routine for identifying any indexed shapes that are similar or identical to a search shape included on an inputted search drawing also having extraneous information, the querying routine applying the removing procedure to the search drawing and the orienting procedure to the search shape, and including a procedure for comparing the search shape to the indexed shapes.

56.   The program of claim 55 wherein the procedure for removing the extraneous information identifies a border and a title block on each inputted drawing and removes the border and the title block.

57.   The program of claim 55 wherein the procedure for removing the extraneous information identifies all objects on the inputted drawing, defines the indexed shape as the largest object on the drawing, and removes all objects except the largest object.

58.   The program of claim 55 wherein the procedure for removing the extraneous information identifies all objects on the inputted drawing by locating adjacent pixels of information and defining objects as collections of contiguous pixels of information.

59.   The program of claim 55 wherein the procedure for removing the extraneous information back fills the inputted drawing to define an interior space of the indexed shape.

60.   The program of claim 59 wherein the step of backfilling includes the steps of backfilling a portion of the drawing outside the indexed shape, and filling all other portions of the drawing with a second color.

61.   The program of claim 55 wherein the procedure for removing the extraneous information includes removing pixels of information about a perimeter of the indexed shape.

62.   The program of claim 55 wherein the orienting procedure calculates the center of mass of the indexed shape.

63.   The program of claim 55 wherein the orienting procedure rotates the indexed shape by an amount corresponding to a most common angle of the indexed shape.

64.   The program of claim 62 wherein the orienting procedure rotates the indexed shape so that the center of mass is in a predetermined location relative to a pair of axes.

65.   The program of claim 55 wherein the procedure for removing the extraneous information includes separating each closed object on the drawing from the remainder of information on the drawing, and identifying the largest closed object as the indexed shape.

65.   A system for generating a database of shapes and for searching the database for shapes that correspond to a shape provided on a drawing having other objects, including:

        means for inputting the drawing into the system;

        means for removing the other objects;

means for orienting the shape in a predetermined orientation;

means for storing the oriented shape in the database; and

means for comparing the oriented shape to the shapes in the database.

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